24606-11

P-30-1B

P-Line

POWER SUPPLIES UNLIMITED

NJE CORPORATION Kenilworth, New Jersey

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INSTRUCTION MANUAL

P LINE

SERIES REGULATED

MODULE SUPPLIES

SERIAL NUMBER 24606-11

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WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES WHICH ARE DANGEROUS AND CAN BE FATAL IF CONTACTED BY OPERATING PERSONNEL. EXTREME CAUTION MUST BE EXERCISED WHEN WORKING WITH THIS EQUIPMENT.

INTRODUCTION

DEVIATIONS

This manual covers the Standard NJE power supplies as indicated in Section 1 herein. Where deviations to the specifications are built into equipment at customer's request, the nature of the deviation as it affects this manual is indicated in a Specification Sheet which precedes Section 1. If special schematic drawings, parts placement drawings and spare parts lists are required for the deviation they will be found in Section V of the manual, in place of the Standard material.

CORRESPONDENCE

All correspondence must reference the complete description of the unit as shown on the identification label located at the rear of the unit.

In requesting spare parts or information relative to parts, the Reference Designation, the rating, the description and the NJE Part Number must be specified for each part in question.

DESIGN IMPROVEMENTS

N.J.E. Corporation reserves the right to make design improvements on any instrument without prior notice.

REPRODUCTION

No material, drawings, text, figures or any part of this instruction manual may be reproduced without express written consent of N.J.E. Corporation.

REPAIR SERVICE

N.J.E. Corporation provides complete repair facilities at the main plant and at local service centers as listed on the back of this manual. These repair facilities are adequately staffed with factory trained technicians to assure our customers of the most knowledgeable and expedient servicing of our equipment. All equipment forwarded to these facilities must be adequately packaged to prevent damage in transit.

OUT OF WARRANTY SERVICE:

Forward defective equipment to factory or local service center prepaid. A full description of difficulties encountered or the repair required should accompany this shipment. An estimate of the cost of repair will be submitted to you. The necessary servicing will be performed only upon receipt of your written service orders. Your equipment will be returned to you via collect shipment unless otherwise specified on your service order.

IN WARRANTY SERVICE:

If during the warranty period the power supply indicates an inherent defect, immediately communicate with your nearest NJE Field Representative in your area. If, after examination, he concurs that the unit is defective under the warranty conditions, he will provide written authorization for the return of the unit to the factory or the local field service center, whichever is nearest. N.J.E. Corporation will not assume any transportation charges on incoming equipment without the concurring written approval from its field representative.

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SECTION 1

SPECIFICATIONS

1.1 GENERAL:

The P Line of Series Regulated Power Supplies is designed for use in applications where fixed voltage modules are required as integral parts of associated equipment. The specifications herein are tabulated where ratings change from unit to unit (See Table 1-1) and are generalized into paragraphs where ratings are common.

1.2 GENERAL ELECTRICAL SPECIFICATIONS:

1.2.1 Input:

105 to 125 volts, single phase, 55 to 400 cps, at 1.0 amperes.

1.2.2 Output Voltage and Current:

See Table 1-1.

1.2.3 Static Regulation:

1.2.3.1 Load: At constant input voltage the regulation for load changes is less than 0.05% from half load to full load and less than 0.05% from half load to no load.

1.2.3.2 Line: At constant load, the regulation is less than 0.05% for a line change from 115V to 125V and less than 0.05% for a line change from 115V to 105V.

1.2.4 Ripple:

See Table 1-1.

1.2.5 Transient Response:

For a ±10 volt prolonged step change in line voltage, the output voltage will remain in the regulated region. For a no load to full load or a full load to no load step change, the output will return to within 50 millivolts of the regulated region in less than 50 microseconds.

1.2.6 Meters:

No meters are provided.

1.2.7 Polarity:

The output may be "floated" up to 500V peak above ground. Either polarity may be grounded to chassis.

1.2.8 Duty:

Continuous at ambient temperatures from 0° C to 35° C. Operation above 35° C is allowed provided the output current is derated linearly to zero at 75° C.

1.2.9 Remote Sensing:

Sensing leads, separate from the output leads, provide sensing and load regulation against the voltage at the load rather than the voltage at the output terminals. This eliminates the otherwise unavoidable load regulation due to the resistance of the wires connecting the supply to the load. This feature does not eliminate voltage excursions resulting from load transients through load line impedance.

1.2.10 Remote Programming:

Not provided.

1.2.11 Dualling:

Two or more units may be operated in series to provide higher voltage at rated current. These units may not be operated in parallel.

1.2.12 Termination:

20 inch color coded leads provide interface connection for input, output, remote sensing and ground.

1.2.13 Protection:

Output fuse protects against overload and short circuit. Protective fuse will interrupt input power in the event of internal failure.

1.2.14 Output Capacitor:

Permanently connected to the sensing leads.

1.2.15 Constant Current:

Not provided.

1.2.16 Resolution:

Continuously variable single-turn Output Adjust potentiometer provides a resolution of 250 millivolts.

1.3 MECHANICAL SPECIFICATIONS:

1.3.1 Outline Drawing:

Table 1-1 indicates which Outline Drawing is applicable to the unit in question.

1.3.2 Airflow:

No special precautions are required provided the ambient temperature limits of paragraph 1.2.8 are not exceeded.

1.3.3 Mounting:

Subchassis mounting by means of 4 screws.

1.3.4 Finish:

Flat black paint.

1.4 OPTIONAL FEATURES:

The optional features which are available on any given unit and the general description of these optional features follows:

1.4.1 Suffix (-RP):

Conversion to rack mounted unit.

1.4.2 Suffix (-M):

Addition of meters.

1.4.2.1 Available on (-RP) only.

1.4.3 Suffix (-TB):

Addition of interface terminal board.

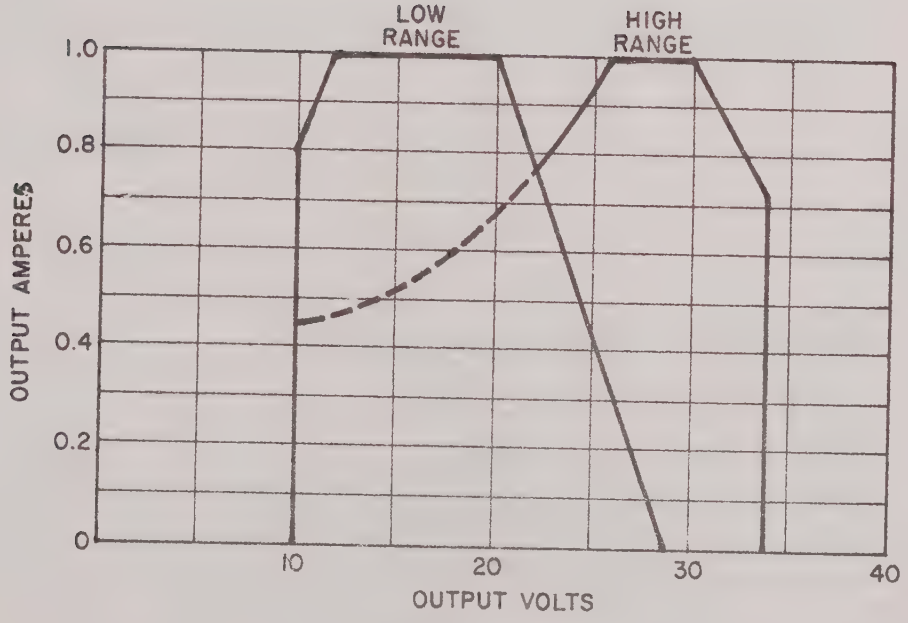
1.4.4 Suffix (-MC):

Addition of dust-cover.

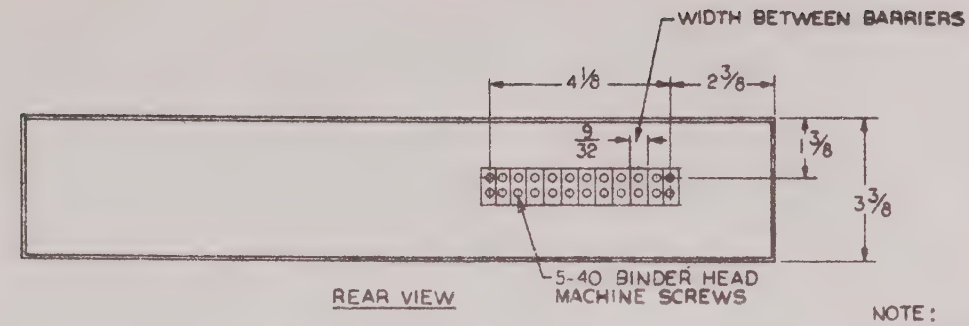
MODEL NO.	OUTPUT		WEIGHT		OUTLINE DWG.	RIPPLE P-P
	VOLTS	AMPS	NET	SHIP		
P-30-1(1)	10-33	0-1	8	10	303339 303417 303418	3MV
P-56-0.5	36-56	0-0.5	8	10		5MV
P-72-0.5	56-72	0-0.5	8	10		5MV

(1) SEE CHART BELOW

TABLE 1-1
TABULATED SPECIFICATIONS

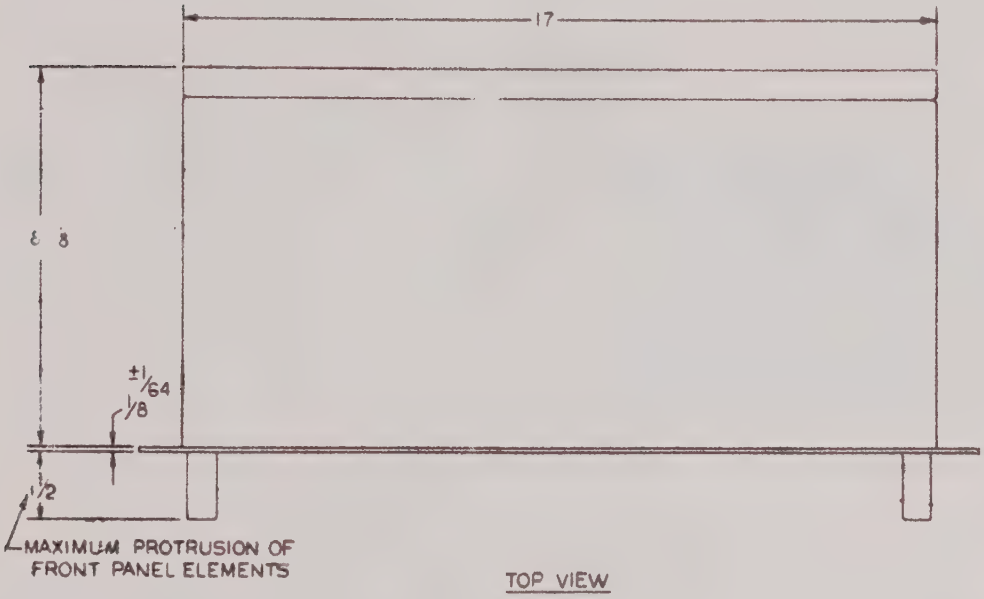


P30-1 RATING

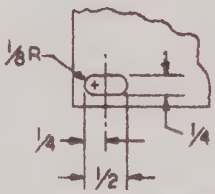


REAR VIEW

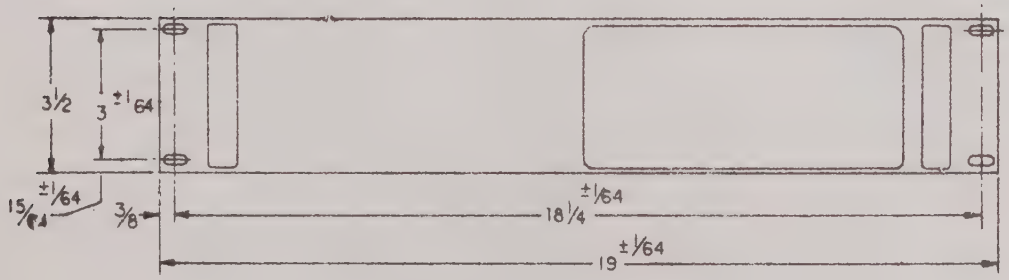
NOTE:
TOLERANCES ARE ±1/32 UNLESS OTHERWISE SPECIFIED.



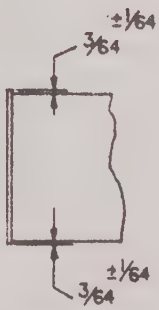
TOP VIEW



TYPICAL NOTCH

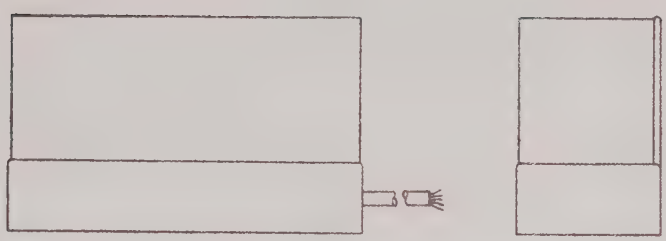


FRONT VIEW

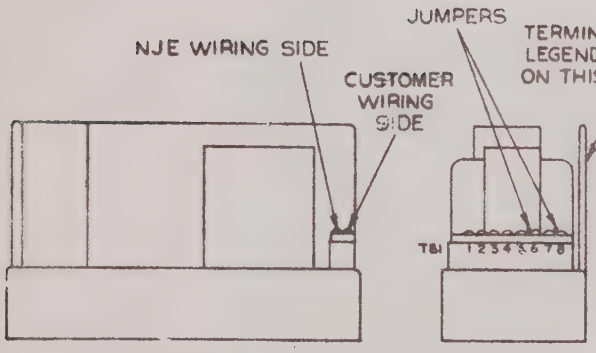


SIDE VIEW
(PARTIAL)

OUTLINE DRAWING
RACK MOUNT (-RP) OPTION



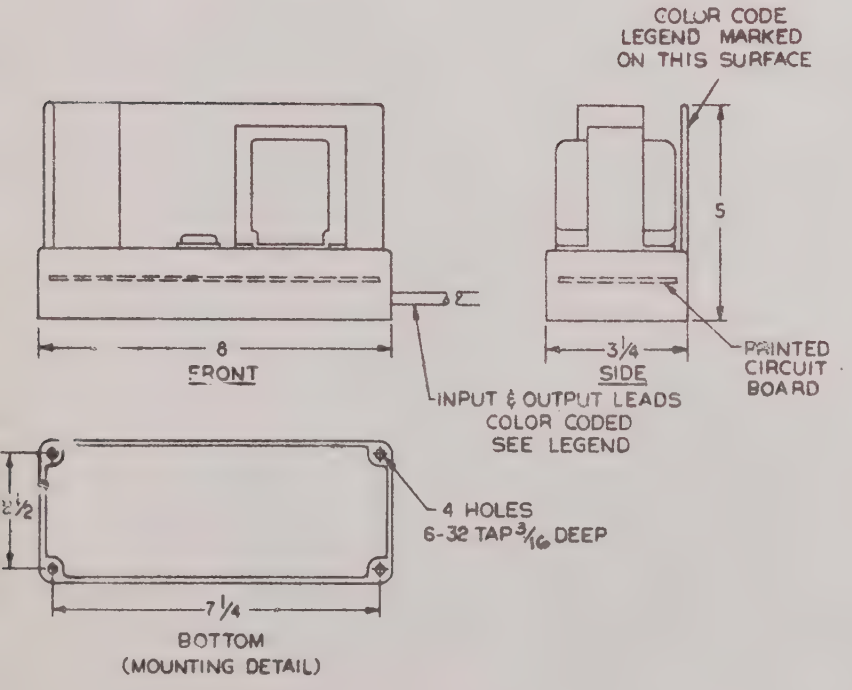
DUST COVER (-MC) OPTION



TB1 TERMINAL BOARD LEGEND				
TERM. NO.	SCREENED FUNCTION	RECOM'D WIRE SIZE	REMARKS	
1	AC COM	NO. 20 AWG	COMMON	
2	AC IN	NO. 20 AWG	HIGH RANGE AC	1
3	AC IN	NO. 20 AWG	LOW RANGE AC	1
4	GRD	NO. 20 AWG	DC GROUND	
5	POS OUT	NO. 20 AWG		
6	POS SEN	NO. 20 AWG	NORMALLY JUMPED TO POS OUT	
7	NEG SEN	NO. 20 AWG	NORMALLY JUMPED TO NEG OUT	
8	NEG OUT	NO. 20 AWG		

1. P30-1-RP ONLY. P72-0.5-RP AND P56-0.5-RP HAVE AC HOT LEAD ON TERMINAL 2. TERMINAL 3 HAS NO CONNECTION.

TERMINAL BOARD (-TB) OPTION



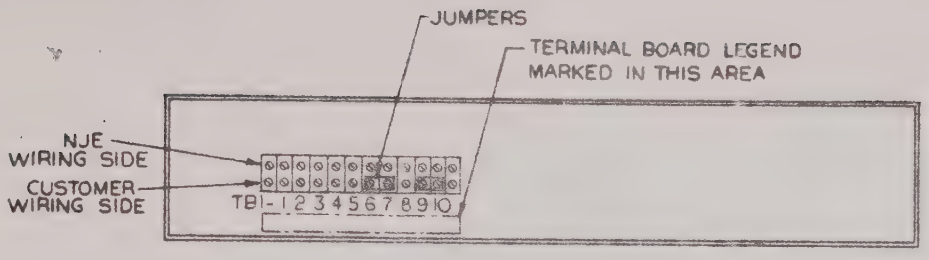
COLOR CODE LEGEND		
FUNCTION	WIRE COLOR	
AC INPUT COMMON	WHITE/GRAY	
AC IN (HIGH RANGE)	GRAY	1,3
AC IN (LOW RANGE)	WHITE/BLACK	1,2
GROUND	BLACK	
POS OUTPUT	RED	
POS SENSING	WHITE/RED	
NEG SENSING	WHITE/VIOLET	
NEG OUTPUT	VIOLET	

1. P30-1
2. P56-0.5
3. P72-0.5

MODULE SUPPLIES

801717

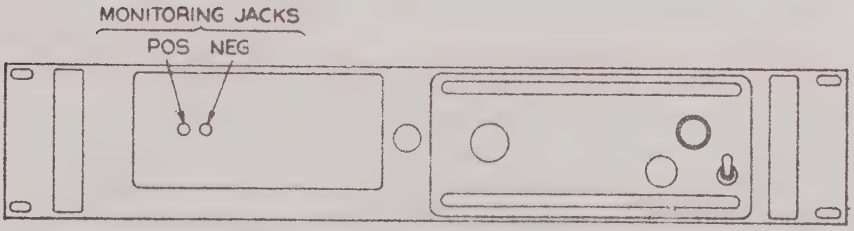
303339
REV. A 1-18-65



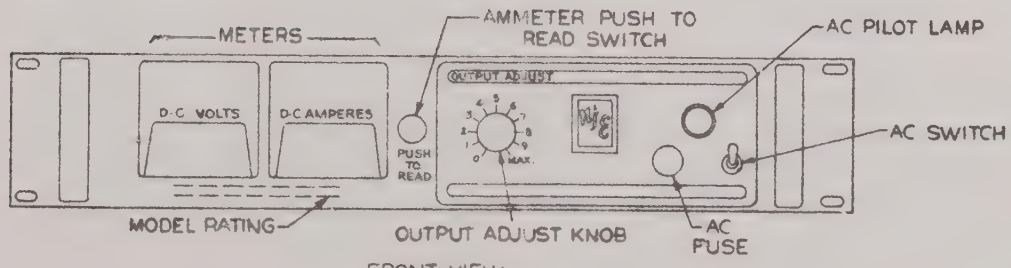
REAR VIEW

TB1 TERMINAL BOARD LEGEND			
TERM NO.	SCREENED FUNCTION	RECOM'D WIRE SIZE	REMARKS
1	AC	NO. 20 AWG	HIGH SIDE OF AC INPUT
2	AC	NO 20 AWG	RETURN SIDE OF AC INPUT
3	LOW RANGE	NO 20 AWG	1
4	COMMON	NO 20 AWG	
5	HIGH RANGE	NO 20 AWG	
6	POS SEN	NO 20 AWG	NORMALLY JUMPED TO POS OUT
7	POS OUT	NO 20 AWG	
8	GRD	NO 20 AWG	DC GROUND
9	NEG OUT	NO 20 AWG	
10	NEG SEN	NO 20 AWG	NORMALLY JUMPED TO NEG OUT

1. P30-1-RP ONLY



FRONT PANEL ELEMENTS (-RP) OPTION



FRONT VIEW

FRONT PANEL ELEMENTS (-RP-M) OPTION

SECTION II

INSTALLATION AND OPERATION

2.1 UNPACKING:

The power supply is shipped in a cardboard carton which is floated on sufficient insulation in a heavy-duty shipping carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The Power Supply was checked electrically and mechanically before it left the factory, and is warranted to be in perfect operating condition. This warranty does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed or missing parts, should be brought to the attention of the transportation company and a claim should be entered. Inspect all components and wiring as well as the mechanical condition of the housing. The literature packed with the supply should be removed and held for reference in operating the equipment.

2.2 INSTALLATION:

Refer to Outline Drawing. This Outline Drawing shows mounting dimensions, air flow requirements, interface wiring information and other data pertinent to proper installation. Careful observance of All the specification requirements in Section I is essential to a proper installation. READ THE SPECIFICATIONS CAREFULLY BEFORE PROCEEDING. Outline drawing included in this section.

When the unit has been properly placed in position, electrical connections should be made in accordance with the following step-by-step procedure.

2.3 STANDARD SINGLE UNIT ELECTRICAL INSTALLATION:

It is recommended that the leads provided with this equipment be terminated at a barrier type terminal board located no more than 20 inches from the module chassis. Other types of disconnect arrangements such as AN connectors are also acceptable. Use 16 gauge wire for all connections unless otherwise specified.

2.3.1 Output Grounding: Connect either the positive (POS OUT - RED lead) or negative (NEG OUT - VIOLET lead) DC output terminal of the supply (depending upon desired output polarity) directly to the chassis ground terminal (GRD - BLACK lead) at the barrier strip on the rear of the chassis, and connect the ground terminal to the system ground.

NOTE: If it is necessary that the power supply circuit float above or below ground, it is recommended that the output terminal should be connected to the chassis ground terminal by a 0.1 microfarad 600 VDC capacitor in place of the direct connection. Use of this by-pass capacitor will improve the stability of the circuit in the ungrounded condition, and reduce the effect of external interference and hum. Refer to Polarity Specification in Section I for maximum limitation on floating voltage permitted.

2.3.2 Output Connections: Connect the positive and negative output terminals (POS OUT - RED lead) and (NEG OUT - VIOLET lead), respectively to the corresponding terminals of the external load. Use heavier gauge wire than that specified if long distances to the load are involved.

2.3.3 SENSING CONNECTIONS:

2.3.3.1 Local Sensing: Jumper connect the (POS OUT - RED lead) terminal to the (POS SENS - WHITE/RED lead) terminal. Jumper connect the (NEG OUT - VIOLET lead) terminal to the (NEG SENS - WHITE/VIOLET lead) terminal. With this connection, the regulation specifications are met at the terminal board or connector only. If it is desired to have accurate regulation at the remote load point rather than at the terminal board, proceed as follows.

2.3.3.2 Remote Sensing: Connect the output terminals to the load per Paragraph 2.3.2 above. Remove the jumpers from (POS SENS - WHITE/RED lead) to (POS OUT - RED lead) and (NEG SENS - WHITE/VIOLET lead) to (NEG OUT - VIOLET lead) respectively. Observing correct polarity, run a twisted pair of No. 20 AWG wire (or larger) from (POS SENS - WHITE/RED lead) to the positive load point and from (NEG SENS-WHITE/VIOLET lead) to the negative load point.

WARNING: DO NOT OPERATE POWER SUPPLY WITHOUT THE SENSING LEADS CONNECTED EITHER REMOTELY OR LOCALLY. MOST CUSTOMER COMPLAINTS OF POOR OPERATION ARE DUE TO IMPROPER SENSING LEAD CONNECTION.

2.3.4 Input Connections: Connect 115 Volts (nominal) 60 cycles per second, signle phase to the input wires as follows:

MODEL	AC "HOT"	AC "COMMON"	
P30-1	WHITE/BLACK	WHITE/GRAY	LO-RANGE
	GRAY	WHITE/GRAY	HI-RANGE
P56-0.5	WHITE/BLACK	WHITE/GRAY	
P72-0.5	GRAY	WHITE/GRAY	

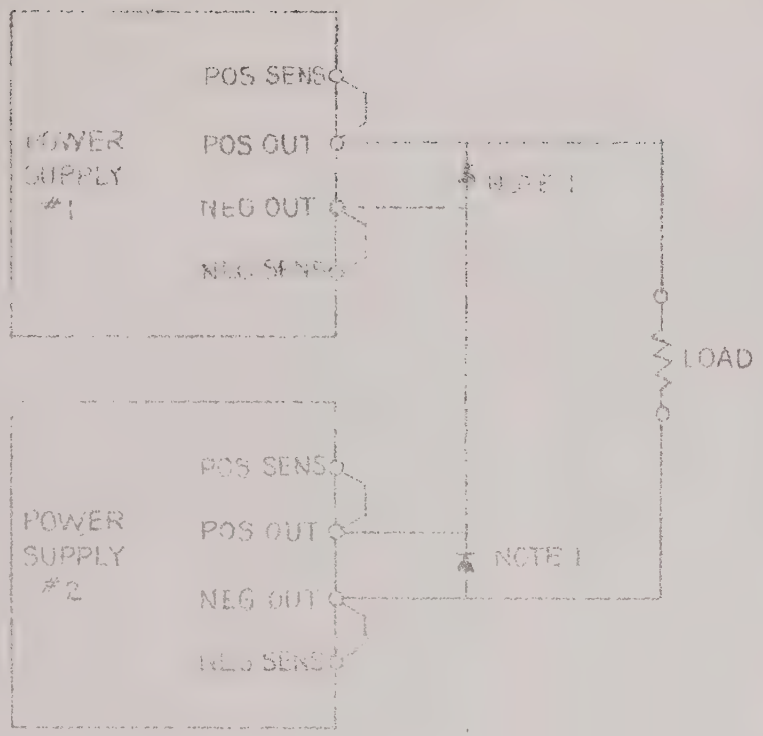
2.4 SERIES CONNECTION:

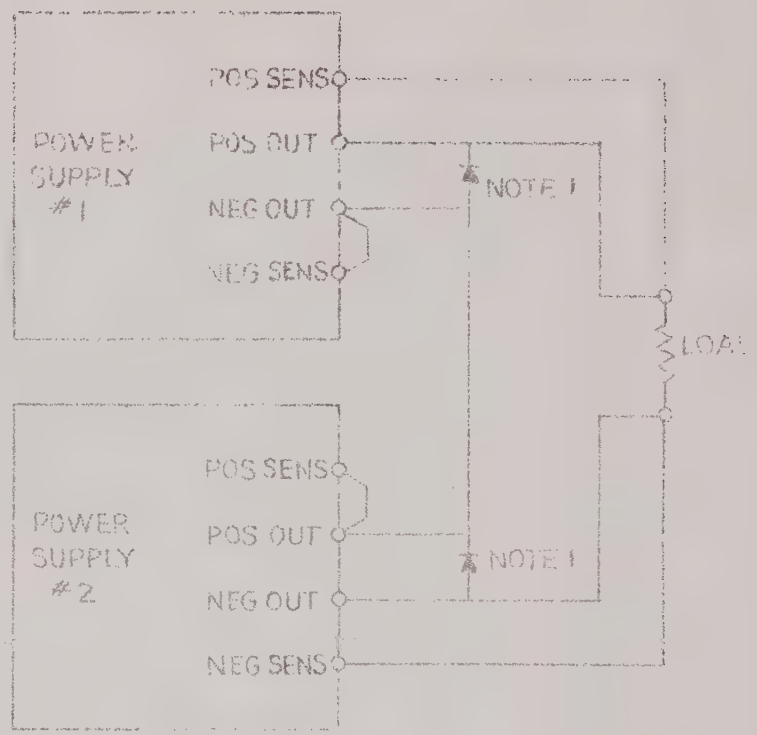
The P-line Power Supplies are equipped with reverse voltage potection diodes and no special precautions are necessary when connecting theunits in series. The connection is straight forward and is essentially the same as connecting two batteries in series. Each supply is independently controlled and delivers an output voltage within its own capability. The total output voltage is, of course, the sum of the individual supplies.

Connection of the series option is clearly shown in Figure 2-2 for the remote sensing mode of operation. If precise regulation at the load is not required, the sensing leads may be left jumpered at the respective output terminals as in paragraph 2.3.3.1.

2.5 OPERATION:

After energizing the AC input line, set the OUTPUT ADJUST by means of a screw driver to the desired output voltage. A voltmeter monitor at the output terminals is required to observe the voltage.


POWER SUPPLY #1
POS SENS
POS OUT
NEG OUT
NEG SENS
NOTE 1
LOAD
POWER SUPPLY #2
POS SENS
POS OUT
NEG OUT
NEG SENS
NOTE 1


POWER SUPPLY #1
POS SENS
POS OUT
NEG OUT
NEG SENS
NOTE 1
LOAD
POWER SUPPLY #2
POS SENS
POS OUT
NEG OUT
NEG SENS
NOTE 1

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SECTION III

THEORY OF OPERATION

3.1 GENERAL:

A simplified diagram, illustrating the basic elements of the circuit, is shown in Figure 3-1. The AC line voltage is converted to a practical value by the power transformer and then is rectified by a bridge diode rectifier. A capacitor input filter smooths the pulsating DC output of the rectifier, providing a low-ripple, unregulated DC voltage to the input of the series regulator. The output voltage, furnished to the load by the series regulator, is continuously monitored by a differential amplifier. This amplifier can be considered to have four interdependent components. They are the voltage to be compared, the reference voltage against which comparison is made, an adjustable means of changing the balance voltage, and lastly the difference voltage. The difference voltage is then properly transformed on an impedance basis by the balanced amplifier and series driver amplifier to control the series regulator in such a way that it will counteract any change in the DC output voltage, thereby furnishing an essentially constant voltage to the external load.

3.2 DETAILED CIRCUIT DESCRIPTION:

Circuit references in the following discussion apply to the schematic diagram at the back of the manual. This diagram shows the electrical relationship of the components without regard to their actual physical location, and is laid out in an arrangement approximately the same as that in the Block Diagram Figure 3-1. The power supply is energized by connecting 115 volts (nominal) 60 cycles, single phase, to the input wires.

The Power Transformer (T1) converts the 115V AC input line to an appropriate value on its secondary winding. This voltage is rectified by a Bridge rectifier (CR1 thru CR4), providing a pulsating DC output which is smoothed by the capacitor input filter (C1) and applied through a regulating transistor assembly to the output load. The series regulators are as follows:

MODEL	REF
P30-1	Q6
P56-0.5	Q6 and Q7
P72-0.5	Q6 and Q7

The differential amplifier consists of a "balanced type" of amplifier to assure the minimum sensitivity to fluctuations of the ambient temperature or operating voltages. The input (comparing) signal for the amplifier is derived from a sensing voltage divider connected across the output of the supply. This divider consists of resistors (R8, R10, R13 and R17). The resistance setting of (R8) determines the operating value of the DC output voltage of the supply in a manner which will be further explained below. Potentiometer (R8) is the OUTPUT ADJUST control located on the printed circuit board and is a screwdriver adjustment. The diode (CR6) across the sensing leads provides a circulating path when supplies are series operated.

The diode (CR5) in conjunction with its load resistor (R5) provides a highly stable potential of a nominal 5.6 volts DC for use as a comparison voltage by the differential amplifier (Q4 and Q5). When the output of the power supply (measured at the load) is precisely at its selected nominal value, the voltage at the base of transistor (Q5) (derived from the sensing voltage divider) is at the same level as the base of transistor (Q4) and the input stage is in balance. Under this condition, any tendency of the load voltage to vary in either direction will unbalance the amplifier, resulting in corrective action which compensates for the change, and holds the load voltage at its established value.

Transistors (Q4 and Q5) are PNP type units operated in the common-emitter mode. Their outputs, taken across the load resistors (R7 and R9), are direct coupled to the transistor bases of succeeding stage (Q2 and Q3) which consists of one NPN and one PNP transistor operated as a complementary symmetrical amplifier. The output of transistors (Q2,Q3) at its load resistors (R1 and R2) is connected to the base of the driver transistor (Q1). The zener diode (CR7) (Models P-72-0.5 and P-56-0.5 only) provides a means of isolating the large voltage difference between the base of transistor (Q3) and the base of transistor (Q1) (which is effectively the collector of transistor Q3).

The changes in the driver transistor (Q1) cause the series pass transistor (Q6 for model P-30-1), (Q6 and Q7 for model P-72-0.5, P-56-0.5) to increase or decrease in conductivity according to the difference voltage developed.

Capacitors (C2 and C6) provide a short circuit path for any AC voltage that may appear across the load resistors (R1 and R2). Capacitor (C3) suppresses oscillations that tend to occur at this stage of the circuit. Capacitor (C5) is used to decrease the response time of the voltage sensing divider circuit.

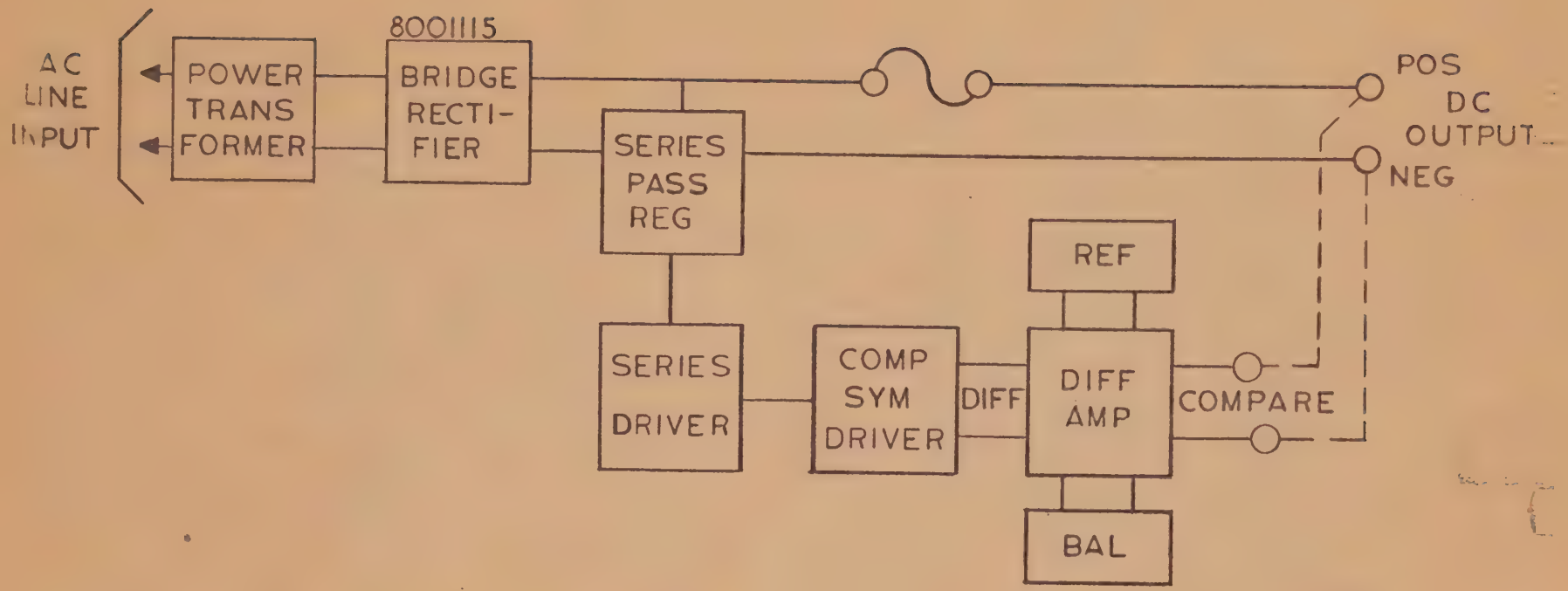
3.3 CORRECTIVE ACTION:

The sequence of corrective action around the series regulator feedback loop is as follows: The base of transistor (Q4) is at a fixed potential with respect to the positive sensing terminal by means of the main reference zener diode (CR5). The input to transistor (Q5) is the difference between the voltage across diode (CR5) (the reference voltage) and the voltage of the sensing voltage divider. When the DC load voltage is at the selected value, the voltage at the divider and the voltage across diode (CR5) are equal, so that the base of transistor (Q4) is at the same potential as the base of transistor (Q5) and the outputs of the two transistors are balanced. When the load voltage tends to deviate from the selected value in either direction, due to a change in the load current or in input line voltage, this will cause the voltage on the sensing divider to differ from the voltage across the reference diode (CR5) and the difference (or "error") voltage unbalances the amplifier stage (Q5) - (Q4). This difference appears in amplified form in the output of this stage, and is further amplified by the subsequent amplifier stages before being applied to the driver transistor (Q1). The output of the driver transistor causes the regulating transistors (Q6 and Q7, when used) to increase or decrease in conductivity in accordance with the error signal so that the overall emitter collector voltage drop absorbs the variation, maintaining an essentially constant value of voltage across the load terminals. Capacitor (C5) assists the amplifier in responding to rapid changes in load voltage by bypassing a portion of the sensing circuit. The more rapid the change, the greater is the initial transfer of voltage direct to the input of the amplifier, enabling it to correct any radical load variation before the excursion becomes significant.

The sensitivity and speed of response of the corrective feedback circuit is such that the above-described action occurs almost instantaneously, and the actual excursion of the load voltage is held to a very small value. The circuit is a true proportional regulator, and must allow a small but finite "error" to exist between the required and actual regulated voltage, so that this error, however small, can generate the correction signal. By proper circuit design, the error is held to a value which remains within the specified regulation allowance of the power supply.

3.3 (cont'd)

When potentiometer (R8) is readjusted to produce a different value of output voltage, the circuit makes a correction similar to that described above. Altering the resistance in the sensing voltage divider unbalances the input stage of the feedback amplifier, which then causes the circuit to produce a new value of voltage such that the drop across resistor (R10) again equals the drop across diode (CR5). Reducing the value of potentiometer (R8) for example, momentarily increases the drop across (R10) (assuming a constant value of output voltage). However, this unbalanced condition at the amplifier input causes the DC output voltage to decrease until the drop across (R10) again equals the drop across (CR5) and the circuit stabilizes at this new operating point, establishing a lower value of DC output voltage.



MODULE SUPPLY
BLOCK DIAGRAM
FIG. 3-1

SECTION IV

MAINTENANCE

4.1. GENERAL: Reference drawings for this power supply are provided in Section V. The exact Schematic Drawing is shown in Figure 5-1. Physical location of components is indicated in the Parts Placement Drawing in Figure 5-2.

This supply is designed for stable operation over long periods of time. However, if trouble develops, standard test equipment normally found in the Electronics Laboratory would be required. If the customer decides to do complete servicing on his premises, one or more of the following pieces of test instruments are required.

Instrument	Range	Remarks
DC Differential Voltmeter	0-500V	Precise regulation check
Oscilloscope	General Purpose	General troubleshooting
Vacuum Tube Voltmeter	General Purpose	Ripple measurements
Multimeter (Ohmmeter)		General troubleshooting
AC Voltmeter (Precision)	0-150V	Precise regulation check
Variable Autotransformer	0-140 V AC 8A	General troubleshooting
Dummy Load	Range depends on supply rating	

WARNING ! !

THE POWER SUPPLY SHALL
BE DE-ENERGIZED WHENEVER
ANY COMPONENTS ARE REPLACED.

4.2 FEEDBACK AMPLIFIER CHECK: There are several methods which can be used in checking the performance and condition of the feedback amplifier.

Except for individually removing the transistors for a check by means of a transistor test set, and making continuity and resistance tests on the circuit and components, all methods require the amplifier to be energized with the proper potentials under the conditions found in the power supply for normal operation. For this reason, it is simplest to test the amplifier in position in the supply, first making certain that its DC power supply consisting of transformer (T1), rectifiers (A1 CR1, A1 CR2, A1 CR3 and A1 CR4), capacitor (A1 C2) and resistor (A1 R1) is functioning properly. This can be quickly ascertained by checking the circuit voltages as indicated on the schematic diagram. Once this is done, the procedures given below can be used to check out the amplifier itself.

4.2.1 Voltage Check: The simplest and most rapid direct check of the amplifier is made by connecting a temporary jumper from the base of transistor (A1Q5) to the base of transistor (A1 Q4), thereby balancing the amplifier input stage, and checking for balanced voltages on the two amplifier stages. Any obvious discrepancy will indicate a defective stage, and simple analysis will pinpoint the defective connection or component. Verification is then made by testing the component itself or repairing the connection.

4.2.2 Signal Tracing Check: Since there is an inherent amount of ripple at the input to the amplifier, this ripple signal can be used as a test signal for observing the amplifier performance with the aid of a test oscilloscope. (Ignore any spikes in the waveform. Use only the basic ripple signal when making amplitude calculations). In the event that the ripple is too small for practical use, a small 60-cycle sine-wave voltage of convenient amplitude (less than 1/4 volt) can be injected into the amplifier, applying it across the sensing terminals 17 and 18 for convenience. Measurement of the ripple at the input to the amplifier, and at the output of each successive amplifier stage will provide an effective check for amplifier performance. The ripple amplitude measured across the bases (or input) of the second stage transistors (A1 Q2) and (A1 Q3) should be 20 to 40 times the amplitude at the input to the first stage. The ripple at the base of the next stage, should be 15 to 30 times the ripple at the input to the previous stage. Radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual test.

4.2.3 Stability Check: A detailed check for improper drift and intermittent failure can be made by utilizing a test rig similar to that shown for precise regulation check in Figure 4.2. The voltage across the zener diode reference source (A1 CR5) is "bucked out" and monitored by a 0 to 1-volt (or smaller scale, if available) high impedance DC voltmeter. Drift or random instability will be readily visible in this test. Output voltages of the successive amplifier stages can then be monitored in the same manner. When checking a given amplifier stage by this method, the output of the previous stage should be shorted, to prevent external voltage variations from reaching the stage under test. When installing a new transistor in place of one shown to be defective, the stability check should be repeated, to make certain that the trouble has been eliminated.

4.3 MEASUREMENTS AND TESTS

4.3.1 Sensing Connection: Sensing lead connections are of utmost importance in making proper regulation measurements. It is recommended that the sensing connections be made directly at the output terminal points rather than at a remote load point. Although the regulation measurement should check correctly at a remote point as well as at the supply terminals, it is well to ascertain that the power supply itself is operating properly without introducing the possibility of extraneous external wiring problems. Thus, all measurements should be made with "local" sensing connections, i.e., with the Sensing terminals jumpered directly to the corresponding Output terminals. One other point of caution in proper measurement technique is the following:

> It is absolutely essential that the measuring equipment connections be made directly to the sensing terminals, whereas the load lead connections must be made directly to the Output terminals. Figure 4-1 shows proper and improper connections for measurements taken with "local" and "remote sensing" connections.

Various measurements can be made using essentially the same connections, but using different instrumentation. The following paragraphs describe the basic parameters which may be tested.

4.3.2 Regulation Checks: Since regulation of modern power supplies can be as low as 0.001%, special measuring techniques must be employed to accurately check the various regulation parameters. It is necessary to use an external source of DC voltage of approximately the same value as the power supply output as a "bucking" source, connected as shown in Figure 4-2. This DC bucking voltage can be either an electronic, null balance differential voltmeter, or a group of batteries connected in series (or another power supply), furnishing a DC potential slightly larger than the output voltage of the power supply under test. When using an differential voltmeter, the voltmeter is built right into the test equipment. When a "bucking" battery is used the voltmeter should have a full-scale range low enough to detect the magnitude of regulation expected.

A multi-tester used on the 1 volt range will usually be adequate, since approximately 10 millivolts can be observed reasonably well. The point to note here is that the voltmeter is used to measure only the difference between two almost equal voltages. The balance adjustment (either in the electronic unit, or the test set-up of the diagram) is used to bring the meter needle to approximately midscale before testing, so that the deviation above or below the normal output of the supply under test can be observed.

4.3.3 Static Load Regulation: The dummy load (R1) of Figure 4-2 is selected to draw full load current at the nominal output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts. When load changes are made, it may be necessary to readjust the line voltage to its nominal value.

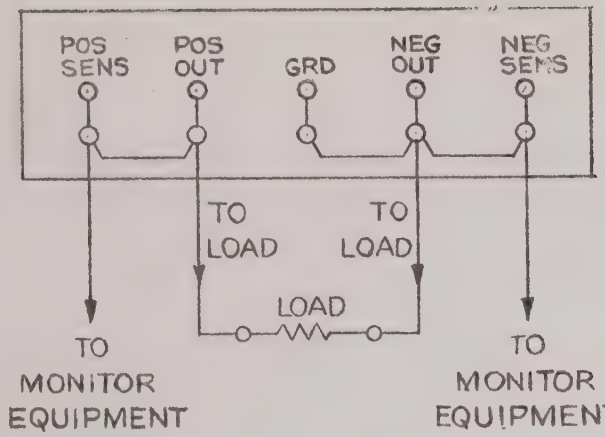
4.3.4 Static Line Regulation: With the load set at some fixed value, either no load, full load, or some in-between point, the input line is varied by means of the variable auto-transformer shown in Figure 4-2. Note that if this measurement is made under a heavy load condition, the auto-transformer must be selected to supply the necessary input volt-amperes. The difference between the differential voltmeter reading for different line voltage conditions (allowing the needle to come to rest before reading), gives the static line regulation in volts.

4.3.5 Ripple: Either a sensitive VTVM or oscilloscope may be connected directly across the power supply sensing terminals for this measurement. The same set-up as used for the regulation checks may be used if it is desired to observe the ripple under different conditions of the voltage and load current. Be sure to make the measurement connections at the sensing terminals rather than at the load terminals.

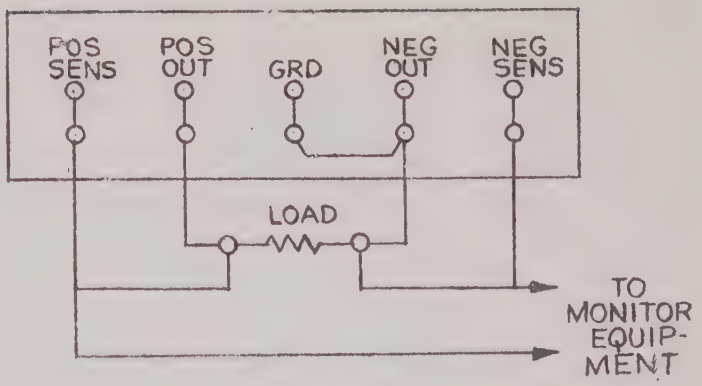
4.3.6 Dynamic Regulation and Recovery Time: In the test-set-up described above for Static Load or Line Regulation, a calibrated oscilloscope should be substituted for the differential voltmeter. Maximum deflection and recovery time are measured directly as a dummy load of appropriate value is switched in and out of the circuit. A mercury switch is recommended to minimize arcing, or else an electronic switch should be used. If available, the latter is highly desirable, since the response is readily displayed on the oscilloscope. If recovery time is the parameter under investigation, the switch must be such that the rise and fall time of the current step be at least five times faster than the anticipated recovery time.

4.3.7 Stability: A detailed check for improper drift and intermittent failure can be made by utilizing the same test arrangement as for static regulation measurements. The only requirement is that the differential voltmeter used must have stability of an order of magnitude better than that of the power supply. If available, a stable recorder may be substituted for the differential voltmeter in the drawing, thereby procuring a continuous tracing of the power supply stability.

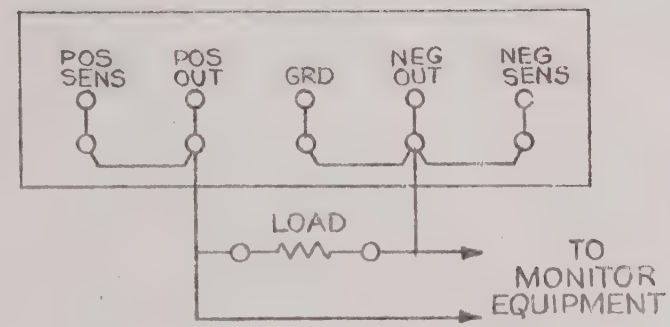
CORRECT



CORRECT



INCORRECT



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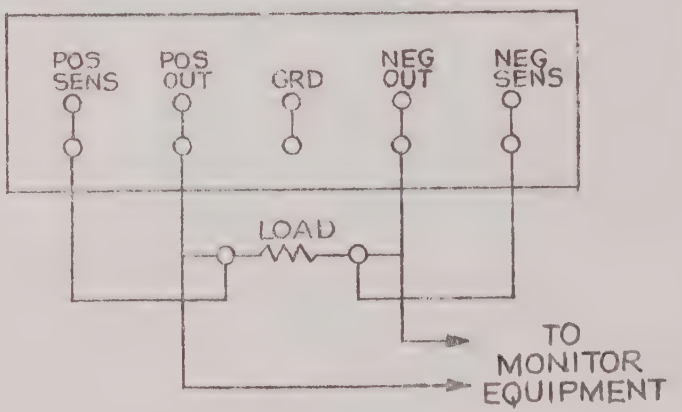
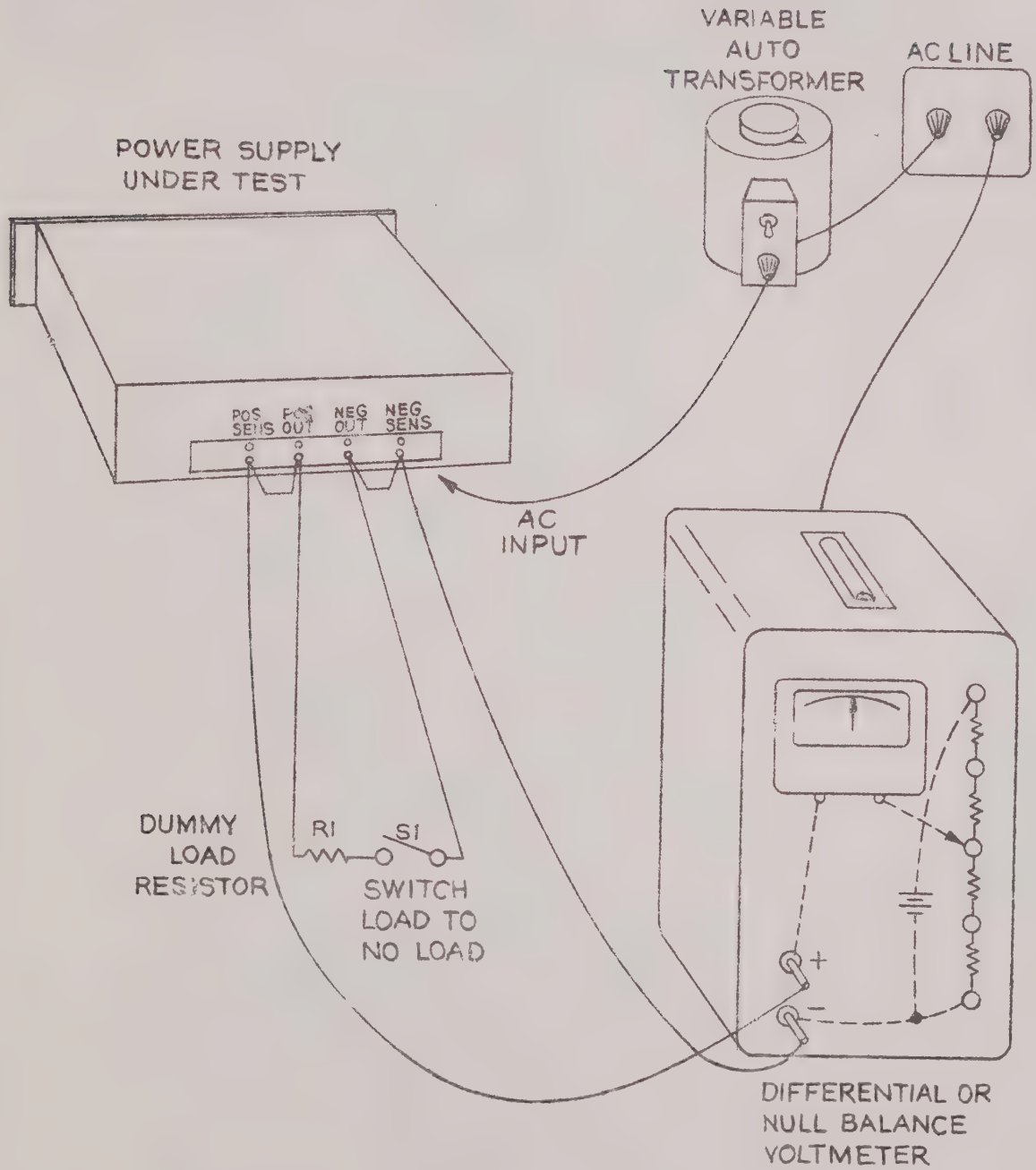


LOCAL SENSING

REMOTE SENSING

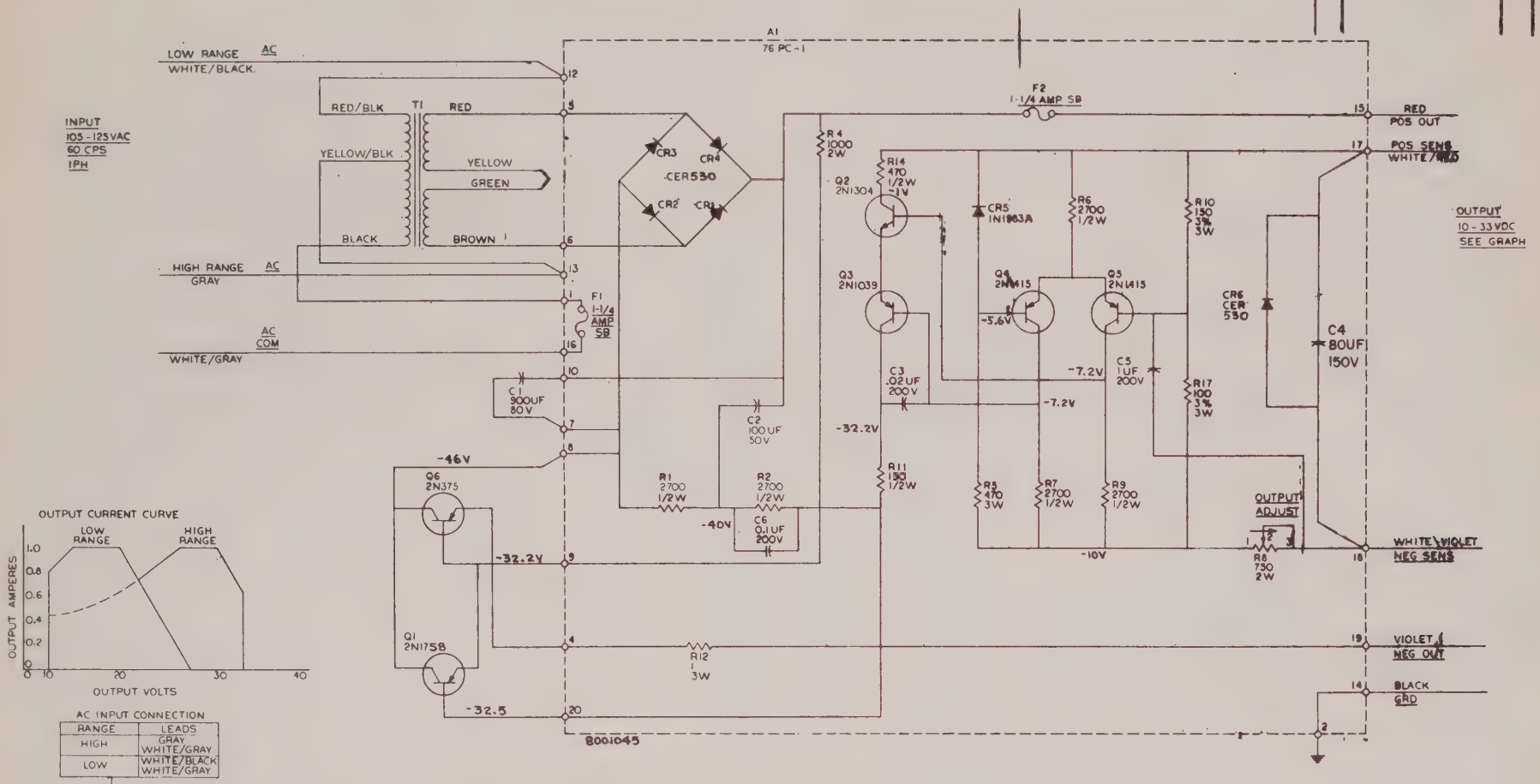
MEASUREMENT CONNECTIONS WITH LOCAL SENSING AND REMOTE SENSING



REGULATION CHECK
TYPICAL LAYOUT

FIG. 4-2

A	[illegible]	[illegible]	[illegible]
B	ECO 4334	8-24-[illegible]	
C	ECO 4653	JS 8-19-[illegible]	
D	C4 WAS 50 UF	[illegible]	



OUTPUT CURRENT CURVE

AC INPUT CONNECTION

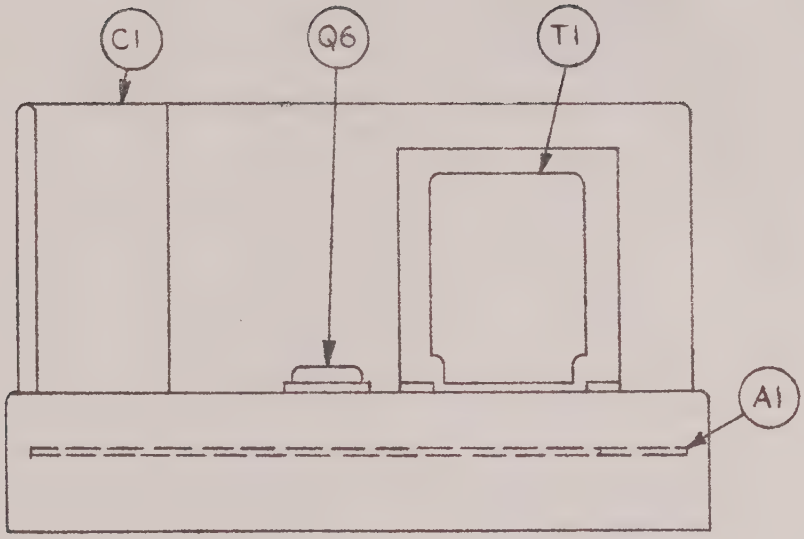
RANGE	LEADS
HIGH	GRAY WHITE/GRAY
LOW	WHITE/BLACK WHITE/GRAY

NOTES:

1. THIS UNIT IS EQUIPPED WITH SEPARATE OUTPUT SENSING TERMINALS. THESE SENSING TERMINALS MUST BE CONNECTED DIRECTLY TO THE LOAD TERMINALS (OBSERVING POLARITY) BY MEANS OF LEADS PROVIDED. DO NOT OPERATE SUPPLY WITH SENSING LEADS UNCONNECTED.
2. ALL VOLTAGES MEASURED WITH RESPECT TO POSITIVE OUTPUT TERMINAL OF UNIT. INPUT VOLTAGE SET AT 115VAC. OUTPUT VOLTAGE SET AT 30VDC. LOAD 1.0ADC

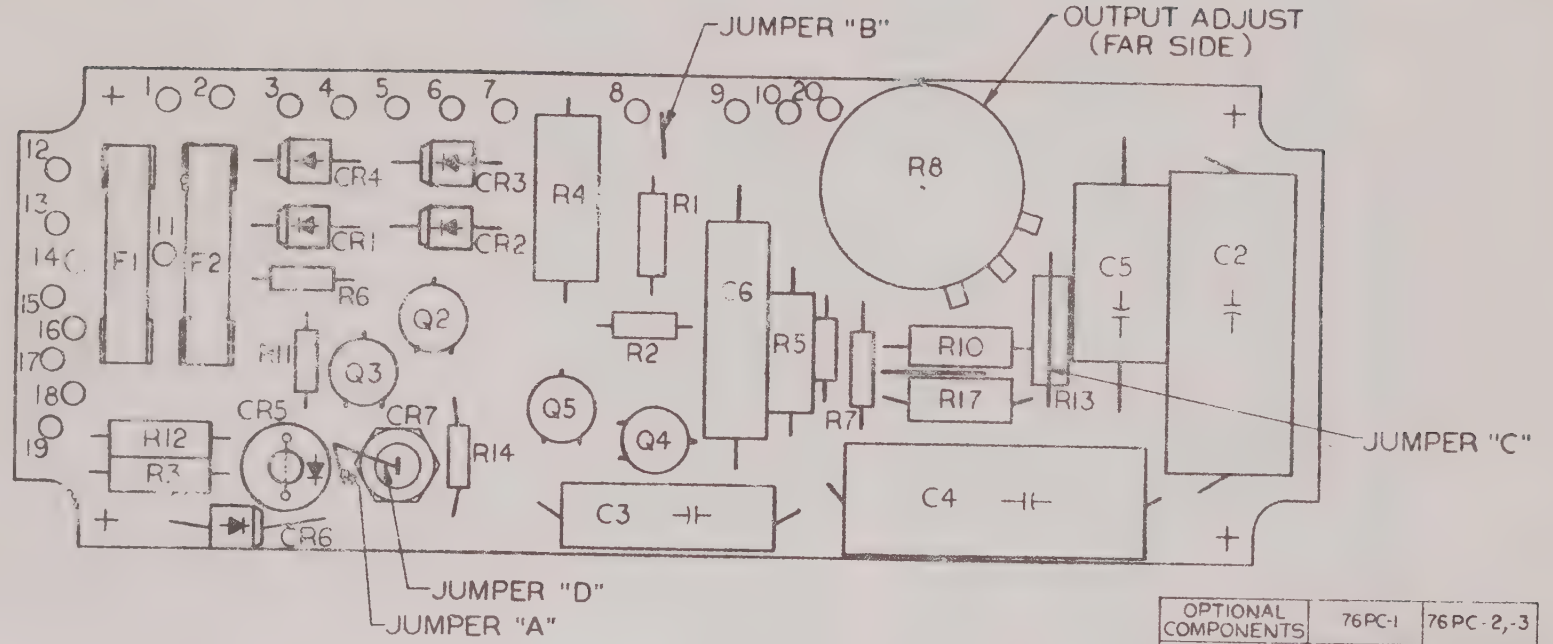
SCHEMATIC FOR DC POWER SUPPLY
MODEL P30-1B
FIG. 5-1

101322



PARTS PLACEMENT - MAJOR COMPONENTS

FIG. 5-2A



OPTIONAL COMPONENTS	76PC-1	76PC-2,-3
CR7	NOT USED	USED
JUMPER "A"	USED	NOT USED
R3	NOT USED	USED
JUMPER "B"	USED	NOT USED
JUMPER "C"	USED	NOT USED
R13	NOT USED	USED
JUMPER "D"	NOT USED	USED

PRINTED CIRCUIT
PARTS PLACEMENT
76 PC-1, -2, -3

FIG. 5-2B

303338

ABBREVIATIONS USED IN SPARE PARTS LIST

In Description Column: "SA" is used to mean "Same As" and "PO" is used to mean "Part Of". Where these symbols are used, the UNIT QTY, SPARE QTY, UNIT PRICE and NJE PART NO. columns are all blank.

In Value Column: The use of the letter R to indicate a decimal point is illustrated by the following examples: 5.6Kn is written as 5R60K. 1/2 Watts is written as R500 W. The use of zeroes does not imply a precision to the indicated number of decimal places but is a requirement of the proper handling of the Data Processing Cards from which these spare parts lists are written.

The standard symbols for electrical units are used and usually appear in the columns immediately to the left of the dashed and solid lines in the Value field. In all cases, the symbol n is not printed for resistors and is understood. For example: 200n is written 200 and 2.7Mn is written 2R70 M.

In Reference Designation Column: The reference designations are those which interrelate the Spare Parts List, the Schematic Diagrams and the Parts Placement drawings. The symbols are those of MIL - STD 16. Where the reference designation is an "A" (meaning a subassembly) a Spare Parts List bearing the NJE Part Number of that assembly is included in the Spare Parts List section.

Deviations: Where minor deviations are accomplished by modifying a standard unit, a Spare Parts List which only shows the deletions and additions from the enclosed standard Spare Parts List is used.

N J E Corp. KENILWORTH, N.J. — Spare Parts List

MODEL P30 1 — 82042 —

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
A1				80422	01	01	
C1	CAP FXD ELECT	900UF	80 V	13	01	01	3.00
C2	CAP FXD ELECT	100UF	50 V	514	01	01	1.90
C3	CAP FXD PAPER	.02UF	200 V	169	01	01	.25
C4	CAP FXD ELECT	50UF	150 V	327	01	01	1.50
C5	CAP FXD PAPER	1UF	200 V	172	01	01	2.50
C6	CAP FXD PAPER	.1UF	200 V	170	01	01	.50
CR1	DIODE RECTIFIER S	750MA	300 V	138	05	02	1.20
CR2	SA CR1						
CR3	SA CR1						
CR4	SA CR1						
CR5	DIODE BKDOWN 10PC	150MW	5.6 V	135	01		5.00
CR6	SA CR1						
F1	FUSE CARTRIDGE	1.25 A	125 V	337	12	10	.25
F2	SA F1						
Q1	TRANSISTOR PNP GE	12 W	75 V	394	01	01	6.25
Q2	TRANSISTOR NPN GE	150MW	20 V	391	01	01	1.75
Q3	TRANSISTOR PNP GE	500MW	40 V	390	01	01	6.00
Q4	TRANSISTOR PNP GE	200MW	25 V	393	02	01	1.75
Q5	SA Q4						
Q6	TRANSISTOR PNP GE	60 W	60 V	141	01	01	6.90
R1	RES FXD COMP 5PCT	2.70K	.500 W	185	02	01	.20
R2	SA R1						
R3	NOT USED						
R4	RES FXD COMP 5PCT	1.00 K	2 W	188	01	01	.36
R5	RES FXD WW	470.00	3 W	367	01	01	.86
R6	RES FXD COMP 5PCT	2.70K	.500 W	185	03	01	.20
R7	SA R6						
R8	RES VAR WW	750.00	2 W	382	01	01	4.00
R9	SA R6						
R10	RES FXD WW	150.00	3 W	1628	01	01	.86
R11	RES FXD COMP	150.00	.500 W	55	01	01	.10
R12	RES FXD WW	1.00	3 W	366	01	01	.86
R13	NOT USED						
R14	RES FXD COMP 5PCT	470.00	.500 W	184	01	01	.20
R15	NOT USED						
R16	NOT USED						
R17	RES FXD WW	100.00	3 W	263	01	01	.86
T1	TRANSFORMER	TRANSFORMER		82072	01	01	
XQ1	SOCKET TRANSISTOR	2PIN		396	01	01	1.00
XQ2	SOCKET TRANSISTOR	4PIN		128	04	01	.70
XQ3	SA XQ2						
XQ4	SA XQ2						
XQ5	SA XQ2						
XQ6	HOLDER TRANSISTOR	2PIN		4464	01	01	.70
XQ7	HOLDER TRANSISTOR	2PIN		4464	01	01	.70

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
2 - Unit Price shown above is subject to change without prior notice.
3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
4 - Spare Quantity shown above is recommended quantity for one year isolated service.

MODEL P30 1 8204A2 PAGE NO. 1

REFERENCE DESIGNATION	DESCRIPTION - VENDOR NAME*	RATINGS VENDOR PART NO.*	MFR PART NO	QTY USED	SPARE QTY	UNIT PRICE
A1		8042Z		01	01	
C1	CAP FXD ELECT	900UF 80 V	13	01	01	3.00
C2	CAP FXD ELECT	100UF 50 V	514	01	01	1.90
C3	CAP FXD PAPER	.02UF 200 V	169	01	01	.25
C4	CAP FXD ELECT	50UF 150 V	327	01	01	1.50
C5	CAP FXD PAPER	1UF 200 V	172	01	01	2.50
C6	CAP FXD PAPER	.1UF 200 V	170	01	01	.50
CR1	DIODE RECTIFIER S	750MA 300 V	138	05	02	1.20
CR2	SA CR1					
CR3	SA CR1					
CR4	SA CR1					
CR5	DIODE BKDOWN 10PC	150MW 5.6 V	135	01		5.00
CR6	SA CR1					
F1	FUSE CARTRIDGE	1.25 A 125 V	337	12	10	.25
F2	SA F1					
Q1	TRANSISTOR PNP GE	12 W 75 V	394	01	01	6.25
Q2	TRANSISTOR NPN GE	150MW 20 V	391	01	01	1.75
Q3	TRANSISTOR PNP GE	500MW 40 V	390	01	01	6.00
Q4	TRANSISTOR PNP GE	200MW 25 V	393	02	01	1.75
Q5	SA Q4					
Q6	TRANSISTOR PNP GE	60 W 60 V	141	01	01	6.90
R1	RES FXD COMP SPCT	2.70K .500 W	185	02	01	.20
R2	SA R1					
R3	NOT USED					
R4	RES FXD COMP SPCT	1.00 K 2 W	188	01	01	.36
R5	RES FXD WW	470.00 3 W	367	01	01	.86
R6	RES FXD COMP SPCT	2.70K .500 W	185	03	01	.20
R7	SA R6					
R8	RES VAR WW	750.00 2 W	382	01	01	4.00
R9	SA R6					
R10	RES FXD WW	150.00 3 W	1628	01	01	.86
R11	RES FXD COMP	150.00 .500 W	55	01	01	.10
R12	RES FXD WW	1.00 3 W	366	01	01	.86
R13	NOT USED					
R14	RES FXD COMP SPCT	470.00 .500 W	184	01	01	.20
R15	NOT USED					
R16	NOT USED					
R17	RES FXD WW	100.00 3 W	263	01	01	.86
T1	TRANSFORMER	8207Z		01	01	
XQ1	SOCKET TRANSISTOR	2PIN	396	01	01	1.00
XQ2	SOCKET TRANSISTOR	4PIN	128	04	01	.70
XQ3	SA XQ2					
XQ4	SA XQ2					
XQ5	SA XQ2					
XQ6	HOLDER TRANSISTOR	2PIN	4464	01	01	.70
XQ7	HOLDER TRANSISTOR	2PIN	4464	01	01	.70

MANUFACTURER'S REPRESENTATIVES

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Inglewood, California
OR 8-6144

California San Francisco
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REgent 9-5517

Canada, Ontario
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CLearwater 2-5604

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Ridgway Associates
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Cleveland 34, Ohio
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Penna., Philadelphia
Burlingame Associates, Ltd.
222 Long Lane
Upper Darby, Pa.
JAckson 8-6080

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Carey-Wolf Co.
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Ft. Worth, Texas
TA 3-5383(Dallas)

Texas, Ft. Worth
Carey-Wolf Co.
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Ft. Worth, Texas
PE 8-1702

Texas, Houston
Carey-Wolf Co.
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Houston, Texas
OL 4-2114

Washington, Seattle
Ray Johnson Co., Inc.
1011 N.E. 69th Street
Seattle 15, Washington
LA 4-5170

Washington, D. C.
Burlingame Assoc., Ltd.
8218 Wisconsin Ave., N.W.
Washington 14, D. C.
OLiver 4-6400

*Local Service Centers.

Our Warranty:

N J E Corp. warrants each power supply manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replacing any defective parts thereof, except tubes, semi-conductors and fuses. This warranty is effective for five years after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started. Written permission must be obtained from the factory, before a supply may be returned for examination.

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